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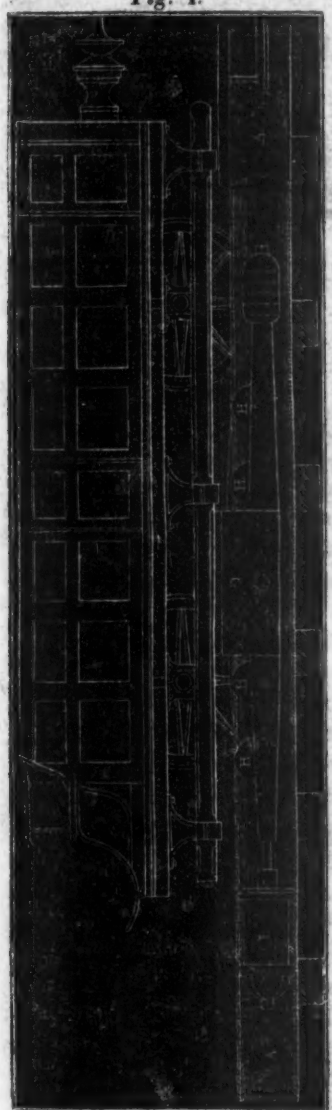
ATMOSPHERIC RAILWAY.

In our July number we published a letter from Messrs. Samuda, Brothers, the patentees of this new mode of working railways, and promised to give in a subsequent number, a further description, with illustrations. In accordance with that promise we now give the main part of a short "treatise on the adaptation of atmospheric pressure to the purposes of locomotion on railways," by M. J. D'A. Samuda, together with several extracts from the examination of Mr. *Cubit*, Mr. *S. K. Brunel*, and Mr. *Robert Stephenson*, engineers of reputation, before a committee of the house of commons, in relation to its advantages as compared with the present locomotive engine system of working railways. Mr. Stephenson appears to take decided ground against the principle, yet he admits that "its safety is nearly perfect if you keep the trains moving in one direction, at the same time"—that is to say there is no danger of running off the track—or the only danger of accident arises from the possibility of two trains meeting, of which it seems to us there is little probability; but the other gentlemen were *decidedly* in its favor, as the extracts from their examination will show; and, "the decision of the committee was unanimously given in favor of the Croydon and Epsom line to be worked by the atmospheric system, to the exclusion of the other."

It is by no means surprising that there should be a diversity of opinion among gentlemen of the profession, as well as others, in relation to an invention which, if it is in reality what its friends claim for it, bids fair to produce a *revolution* in the present mode of railroad locomotion. And even Mr. *Stephenson*, high as he stands as an engineer, and manufacturer of *locomotive engines*, may be as much mistaken, and as honestly so too, as was Dr. *Lardner* in relation to Atlantic steam navigation; but we see no reason to doubt the accuracy of the experiments and the correctness of the observations made by the other gentlemen who were examined by the committee. At all events, we think we see enough in it to warrant us in laying it before our readers, and to request those editors with whom we exchange to do the same to theirs, or to call attention to the Journal containing it.

DESCRIPTION OF CLEGG AND SAMUDA'S ATMOSPHERIC RAILWAY.

Fig. 1.



On this system of working railways the moving power is communicated to the train by means of a continuous pipe or main A, laid between the rails, and divided by separating valves into suitable and convenient lengths for exhaustion; a partial vacuum is formed in this pipe either by steam engines and air pumps fixed at intervals along the road, or by water power, if the nature of the country be such as to afford it.—These valves are opened by the train as it advances, without stoppage or reduction of speed. A piston B, which is made to fit air tight by means of a leather packing, is introduced into the main pipe* and connected to the leading carriage of each train by an iron plate C, which travels through a lateral opening the whole length of the pipe. This lateral opening is covered by a valve G, extending the whole length, formed of a strip of leather riveted between iron plates; the top plates are wider than the groove, and serve to prevent the external air forcing the leather into the pipe when the vacuum is formed; the lower plates fit the groove when the valve is shut, and making up the circle of the pipe, prevent the air passing the piston; as shown in figs. 2, 3 and 4. One edge of this valve is securely held down by iron bars *a a*, fastened by screw-bolts *b b* to a longitudinal rib *c*, cast on the pipe on one side of the lateral opening, and the leather between the plates and the bar being flexible, forms a hinge as in a common pump valve; the other edge of the valve falls on the surface of the pipe on the opposite side of the opening, thus forming one side of a trough F, as shown in figs. 2, 3, 4. This trough is filled with a composition of bees' wax and tallow, which substance is solid at the temperature of the atmosphere, and becomes fluid when heated a few degrees above it. This composition adheres to the edge of the valve, which forms one side of the trough, & that part of the pipe which forms the other, & produces perfect contact between them; but as the piston advances, the valve G must be raised to allow the connecting plate C to pass, and this is effected by four wheels H H H H fixed to the piston-rod behind the piston, and the aperture thus formed serves also for the free admission of air to press on the

* When the first division or section is exhausted, the separating valve is opened, and the front of the piston being thus exposed to the exhausted portion of the pipe, the atmospheric air pressing on the back of it propels it forward in the pipe, and with it the train to which it is attached.

back of the piston: by this operation of raising the valve out of the trough, the composition between it and the pipe is broken, and the air-tight contact must be reproduced. To effect this, another steel wheel R is attached to the carriage, regulated by a spring which serves to insure the perfect closing of the valve by running over the top plates immediately after the arm has passed, and a copper tube or heater N about 5 feet long, filled with burning charcoal, is also fixed to the under side of the carriage, and passes over and re-melts the surface of the composition which has been broken by lifting the valve, and which upon cooling becomes solid, hermetically sealing the valve as before.

Fig. 2.

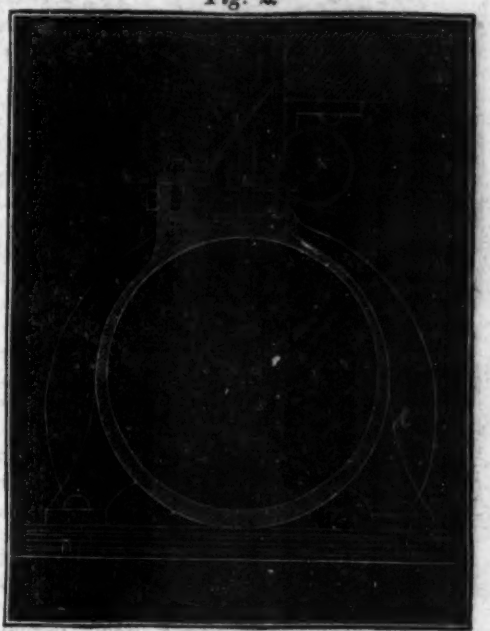
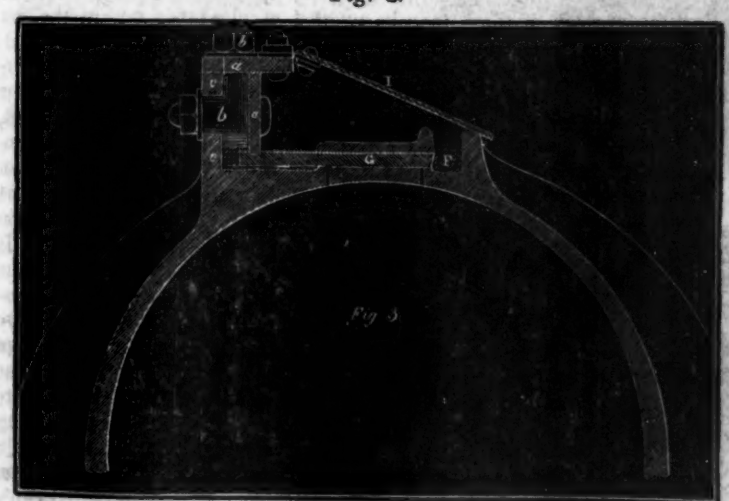


Fig. 3.



Thus each train in passing leaves the pipe in a fit state to receive the next train. A protecting cover, I, formed of thin plates of iron about 5 feet long, hinged with leather, is placed over the valve, and serves to preserve it from snow or rain; the end of each plate underlaps the next in the direction of the piston's motion, thus insuring the lifting of each in succession, which is effected by the wheels D fixed under the carriage.

Fig. 4.

Fig. 5 is the *exit* separating valve, or that at the end of the section nearest to its steam engine; this valve is opened by the compression of air caused by the piston after it has passed the branch which communicates with the air-pump.

Fig. 6 is the equilibrium or *entrance* separating valve. The arrow denotes the direction in which the trains advance. The pipe is exhausted on the side of the valve letered C, and is only prolonged on the other side to allow the piston to enter the pipe before the valve is opened. Attached to one side of the main is a semicircular box B A, divided into two compartments by a partition, of which *a a a* is a sectional view, and thro' which is a circular opening: in the top of the box are two small square holes, one on each side of the partition, furnished with a box slide, by which either or both of them may be covered at pleasure; within the box B A are two valves, *b* and *c*, (of which *b* is the greater,) connected by an arm *d d* to each other, and to a vertical axis *e*, on which they can swing horizontally for about 100 degrees. When the pipe is to be exhausted, the valves are placed by hand or otherwise, in the position represented in the figure; *b* filling the opening in the partition, *c* closing the main. The box slide also covers the hole on the side B of the partition, leaving the other hole open as the exhaustion proceeds; C and B are in vacuum; A and D open to the air. There is then the same pressure on each square inch of *b* and *c*; but *b* being larger than *c* both remain close, for the total pressure on *b* preponderating, will keep *c* against its seat, as will be plain on looking at the figure. But the train on approaching, moves the slide box so as to cover both holes, and a passage is formed thro' which the air in the partition A, rushes into the main C, so that A and B are both in vacuo, and the pressure being removed from *b*, that on *c* *forces*

Fig 5.

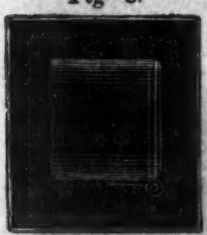
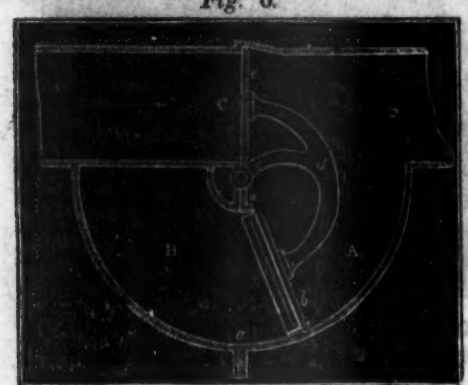


Fig. 6.



it back and allows the piston to pass.—The valve, or rather, piston *b*, is a cup leather, riveted between iron plates and shuts *into* the opening in the partition: *c* is a flat leather valve, and shuts *against* a facing in the main.

The main pipe is put together with deep socket joints, in each of which an annular space is left about the middle of the packing, and filled with a semi-fluid; thus any possible leakage of air into the pipe is prevented.

When it is necessary to stop or retard the train, in addition to the use of a common break, a valve in the travelling piston is opened by the conductor by which means the external air is admitted into the exhausted portion of the pipe, and the propelling power destroyed.

In localities where a sufficient quantity and fall of water can be obtained, the atmospheric system can be worked without the assistance of any machinery whatever: by constructing a tank or tanks (of a total capacity double that of the section of pipe they have to exhaust,) filling them with water, and allowing it to run out through a descending perpendicular pipe about 32 feet long (which it will do by its gravity alone,) the whole of the air contained in the pipe will expand itself into the tanks, and by the time they are half emptied of water half a vacuum will be formed in the pipes, as the air will be expanded into twice its bulk, and the other half will run out while the travelling piston and train are advancing, thus increasing the space in the tanks as that in the pipes is diminishing by the approach of the piston, and by this means maintaining the same degree of vacuum during the whole time the train is passing, whatever be its speed.

Workings of the Atmospheric railway on the Birmingham, Bristol and Thames Junction railway.

The system is in operation on part of the above line between the Great Western railway and the Uxbridge road, on an incline, part 1 in 120 and part 1 in 115.

The vacuum pipe is half a mile long, and 9 inches internal diameter.

The exhausting pump is $37\frac{1}{2}$ inches diameter and $22\frac{1}{2}$ inches stroke, worked by a steam engine of 16 horses' power.

For the purpose of experiment a series of posts were fixed along the half mile every two chains, and a barometric gauge was attached at each end of the pipe, for the purpose of ascertaining the degree to which the pipe was exhausted; a vacuum equal to a column of mercury 18 inches high was obtained in about one minute, and both gauges indicated the same extent of vacuum at the same instant.

The following table shows a fair average of the results obtained during six months.

By following out these results, it will be found that a main pipe of 18 inches diameter will be sufficiently large for a traffic of 5000 tons per day, viz., 2500 tons in each direction, supposing the gradients of the road to average 1 in 100.

Note.—A main pipe, 18 inches diameter, will contain a piston of 254 inches area: the usual pressure on this piston, produced by exhausting the pipe, should be 8 lbs. per square inch (as this is the most economical degree of vacuum to work at, and a large margin is left for obtaining higher vacuums to draw trains heavier than usual on emergencies)—a tractive force of 2032 pounds is thus obtained, which will draw a train weighing 45 tons, at 30 miles per hour, up an incline rising 1 in 100. Two and a half miles of this pipe will contain 23,324 cubic feet of air, $\frac{6}{30}$ths of which, or 12,439 cubic feet, must be pumped out to effect a vacuum equal to 8 lbs. per square inch: the air-pump for this purpose should be 5 feet 7 inches diameter, or 24·7 feet area, and its piston should move through 220 feet per minute, thus discharging at the rate of $24{\cdot}7 \times 220 = 5434$ cubic feet per minute at first, and at the rate of 2536 cubic feet per minute when the vacuum has advanced to 16 inches mercury, or 8 lbs. per square inch, the mean quantity discharged being thus 3985 feet per minute: therefore $\frac{12432}{3985} = 3{\cdot}1$ minutes, the time required to exhaust the pipe; and as the area of the pump piston is 14 times as

great as that in the pipe, so the velocity of the latter will be 14 times as great as that of the former, or 220 feet per minute $\times 14 = 3080$ feet per minute, or 35 miles per hour: but in consequence of the imperfect action of an air-pump, slight leakages, etc., this velocity will be reduced to 30 miles per hour, and the time requisite to make the vacuum increased to 4 minutes: the train will thus move over the $2\frac{1}{4}$ miles section in 5 minutes, and it can be prepared for the next train in 4 minutes more, together 9 minutes; 15 minutes is therefore ample time to allow between each train, and supposing the working day to consist of 14 hours, 56 trains can be started in each direction, or 2520 tons, making a total of 5000 tons per day. The fixed engine to perform this duty will be 110 horses' power, equivalent to 22 horses' power per mile in each direction.

	Number of passengers.	Total load.		Maxim'm speed in ms. pr. hr.	Vacu'm in inches of mercury.
		tons.	cwt.		
June 11, 1840	23	8	0	$22\frac{1}{2}$	18
	23	8	0	$22\frac{1}{2}$	16
	15	7	10	20	19
	21	7	18	$22\frac{1}{2}$	19
	44	9	10	$22\frac{1}{2}$	20
	58	10	7	$22\frac{1}{2}$	19
	57	10	6	18	19
	25	5	9	30	$18\frac{1}{4}$
	75	11	10	$22\frac{1}{2}$	17
	24	8	2	$22\frac{1}{2}$	15
	13	4	12	30	16
	9	7	2	$22\frac{1}{2}$	$16\frac{1}{2}$
June 29, 1840	28	8	2	30	
	28	5	13	30	
	28	5	13	36	
July 24, 1840	21	7	18	30	22
	15	4	15	30	22
	8	4	6	30	23
	15	5	0	30	$21\frac{1}{2}$
Aug. 8, 1840	16	5	1	30	21
	18 and ballast	13	10	18	$20\frac{1}{2}$
	18	5	4	30	$20\frac{1}{2}$
Aug. 10, 1840	15	5	0	30	20
	17 and ballast	13	10	20	22
	10	4	13	30	22
Aug. 11, 1840	28	5	17	30	$20\frac{1}{2}$
	25	5	13	30	20
	14	5	0	30	20
Sept. 24, 1840	23	5	10	36	
Nov. 6, 1840	17	5	3	36	21
	16	5	0	45	$23\frac{1}{2}$
Dec. 9, 1840	11	4	14	45	23
Dec. 15, 1840	15	5	0	36	$22\frac{1}{2}$
Jan. 6, 1841	10	4	13	36	$22\frac{1}{2}$
Feb. 19, 1841	8	4	11	45	$23\frac{1}{2}$

By reference to the dates of this table it will be seen that the workings of the system are equally perfect during all seasons; through the height of

summer, and in the severest winter that we have known for many years: in no single instance during the whole time has any derangement of the machinery taken place, to prevent, or even to delay for one minute, the starting of the trains. The main pipe and valve have considerably improved by working; the composition for sealing the valve has become so much more firmly bedded in its place, that while in June last we were only able to obtain a vacuum equal to a column of mercury 19 to 20 inches high, we now obtain from 22 to 24 inches, and occasionally 25. The speed, originally from 20 to 30 miles per hour, now ranges from 30 to 45. The whole attendance the valve and main received during this period was that of a single laborer for about one hour every week: the composition now in the valve-groove has never been changed; and 56 lbs. weight only has been added to supply the waste: the cost of this composition, which consists of wax and tallow, is 1*s.* per lb.

We have now procured data from which the economy and advantage of this system can be arrived at with certainty.

It is true that we have heard many objections made; and as these objections, if tenable, would involve the principle of the invention, we cannot do better than notice and comment on them here. We have been told, 1st. That our experiments do not prove the applicability of the system to an extended line of road.

2d. That the number of stationary steam engines and establishments required on this system would be an objection, in point of expense, and liability to accident.

3d. That an accident occurring at one of these stations, or anywhere along the pipes, would interrupt the traffic on the whole line; and so strenuously has this objection been urged, that we have heard it asserted that a hole the size of a pin's head, in the sealing composition, would prevent the action of the invention, and thus the traffic might be stopped for a whole day while making fruitless search to discover it.

In answer to the first objection we would say, in every case where a train has been started the pipe has been first exhausted to 18 inches of mercury or upwards: the time of performing this operation is about one minute, and from the barometric gauges fixed at both ends of the pipe the vacuum is ascertained to be formed to an equal extent throughout the whole length without any appreciable difference of time. The pipe laid down is 9 inches diameter, and half a mile long, and a pressure equal to a column of mercury 18 inches high is obtained in one minute by an air-pump 37½ inches diameter, moving through 165 feet per minute. Now it is obvious that if the transverse section of the pipe be increased to any extent, and the area of the air-pump *proportionately* increased, the result will remain unaltered,—*i. e.* half a mile of pipe will be exhausted in one minute; and supposing the air-pump has to exhaust 3 miles, it will perform the operation in 6 minutes; it is also obvious that if the area of the air-pump be increased in a greater proportion than that of the pipe, the exhaustion will be performed more rapidly, or *vice versa*. These results are matters of absolute certainty, as convincingly clear, as that the power of a steam engine must be regulated by the area of the piston on which the steam acts. No person of scientific attainments will for one moment doubt, that if a steam engine were made with a cylinder twice the area of the *largest* cylinder ever set to work, the power obtained would be in proportion to the increased area: and so with the air-pumps before alluded to; the excess of work is immediately arrived at that an air-pump six feet 3 inches diameter will perform over another of 3 feet 1½ inch diameter, the speed of the pistons being the same in both in-

stances. So plain and self-evident is this result, that we believe the most sceptical will admit it to be correct; and this being granted, the applicability of the system to a line of any length must follow; for whatever the length of railroad be, whether 3 or 30, or 300 miles, no different effects have to be produced. The working a road 30 miles long would be the same thing as working 10 roads each 3 miles long. Every 3 miles an engine and air-pump is fixed, which exhausts its own portion of pipe before the train arrives; thus, as the train advances it receives power from each succeeding engine in turn, and without any stoppage, unless required, until it arrives at its final destination, and the air-pumps continuing to work, after the train has passed, on the section they act upon, re-exhaust it in readiness for the next.

The second objection, as to the complexity and outlay attendant on a number of fixed engines, may perhaps be better answered by taking a review of the number and expense of these engines and the duty they are required to perform. On a line 30 miles long, supposing the average distance between the engines to be three miles, there would be 10 engines and air-pumps with their engine houses; and if the railroad were appointed for transporting 5000 tons per day over the whole distance, (considerably more than double the amount carried daily on any railroad in England,) the expense of one of these stationary engine establishments would cost complete £4200, which, multiplied by 10, will give £42,000—total cost on the whole line. But it is a fact which probably must have escaped the notice of those urging this expense as a drawback to the atmospheric system, if they were ever acquainted with it, that to perform a traffic of only 1700 tons per day upwards of one locomotive engine per mile is necessary; and as each locomotive costs £1500, the total capital required for locomotive power on a railroad 30 miles in length would be £45,000; in first cost, therefore, there would be a saving of £3000 in favor of the stationary power;* but this is far from being the most important saving. Every mill owner in Lancashire and Yorkshire, and any person connected with mining operations, will readily admit that his outlay being once incurred for a steam engine to drive his machinery or drain his mine, and his engine being once fixed on *terra firma*, its deterioration, uncertainty of action, or annual expense of maintenance, is not a source of annoyance or anxiety to him. Five per cent. per annum on the cost will more than cover all repairs necessary to be performed to it, and all oil, hemp and tallow used in working it. It is the exception, and not the rule, if a stationary engine once fixed meet with a derangement to render a stoppage necessary.

The annual expenses will be for repairs at 5 per cent. on £42,000	£2,100
For coal for these engines (when transporting 2000 tons per day,)	
6420 tons per year, at 20*s.* per ton - - - - - -	6420
Wages to engine-men and stokers - - - - - - -	1800
	£10,320

The Liverpool and Manchester railway is 30 miles long, and is the only railway that transports as much as 1700 tons per day over its whole distance; and the annual expense of its locomotive department, including coke, is about £50,000 a year.

Need we make any further comment, when the annual expense of power for the atmospheric system is £10,320, and for performing the same traffic on the locomotive system upwards of £50,000 is found necessary? Great

* This saving is in engines only, but it should be recollected that there are many other items, and by reference to the comparative expense of the two systems (page 238, R. R. J.,) it will be seen that the total outlay on the locomotive system is £37,600 per mile, and on the atmospheric £15,120.

as the pecuniary advantages have been shown to be, we must not forget to correct the third objection; viz., the erroneous opinion that the system is faulty because an accident occurring at one of these stations would interrupt the traffic on the whole line. *Prima facie*, this argument is correct, but we have already shown how small the chance of accident is to a stationary steam engine; hundreds are employed day and night without interruption, draining mines; if any derangement in their action were to take place, these valuable properties would be overflowed, and it would require no difficulty to point out many establishments where engines have been in action for years together.* But to make assurance doubly sure, a pair of engines and a pair of air-pumps, each of half the requisite power, may be fixed at each station: should anything cause one engine and pump to stop, the traffic would not be interrupted; the only delay would be the retardation of the train while passing over that section of pipe where only half the power was in action, and until the cause of the stoppage were removed the trains would be some five or six minutes more than usual performing the journey.

The next objection we have to meet is the interruption to the traffic from some derangement in the pipe. This comprehends, 1st, an accident to the pipe itself; and 2d, from the composition not being effectually sealed.

An accident to the pipe can only occur from breakage, and unless designedly perpetrated, could never happen at all. But for the sake of argument we will suppose a pipe has been broken--no matter how; the time of removing it and replacing it with another would be considerably less than the time now necessary to clear off the fragments of a broken engine and train after a collision; and supposing a length of valve to require replacing, it could be done in less time than replacing a rail when torn up by an engine running off the line.

If, instead of one, there were one hundred places along the pipe where the heater had imperfectly performed its functions, the admission of atmospheric air through the composition in these places would only reduce the column of mercury a few inches: no stoppage or interruption of the traffic could possibly occur from this cause, and by comparing the quantity of air pumped out each stroke of the pump, with the quantity that will leak in at each imperfectly sealed spot, any such erroneous idea will be removed. Perhaps on this head, an appeal to experience will be more satisfactory than any argument, however strong: in the whole of our workings, the column of mercury has never varied in height more than 2 inches on the same day; and as it requires eight times the number of minutes to destroy the vacuum in the pipe, when the engine is at rest, that it takes to raise it when in action, it follows that one-eighth only of the power (two horses) is all that is employed to overcome leakage. Perhaps the necessity of stopping the traffic of a line in the event of an accident until the damage is replaced or the obstacle cleared away, should be regarded upon all railways as a peculiar advantage: by this necessity all chance of "running into" is avoided, and where stationary power is employed the difficulties of commuication which a locomotive line has to contend with are overcome. By means of an electric telegraph, every engine station along 100 miles of road may be communicated with in half a minute, and thus the traffic may be suspended and resumed at pleasure.

On examining the facts we have collected, it will be seen that the atmospheric system is grounded on sound principles, and free from many objec-

* At Rock's Mine, Cornwall, an engine has worked day and night without intermission for 3 1-2 years. At the East London water works, a pair of engines, called "the twins," have worked 11 years, with scarcely one hour's rest day or night.

tions that the present railways have to contend with: and a very casual reference to these defects will prove the necessity of substituting an improved system to meet the wants of the public, when this means of travelling becomes fully developed and understood.

The general benefits that railway travelling has conferred, are admitted by all; their introduction has given a new stimulus to industry, and presented increased facilities for the merchant, manufacturer and agriculturist, by bringing the remotest parts of the kingdom within a days journey,—thus enabling goods and agricultural produce to be conveyed to distant towns, for which the previous mode of transport was unequal; indeed, the numerous advantages of railways have been fully appreciated by the public, who have not hesitated to embark immense sums of money to construct them between most of the principal towns.

In proportion as persons have acquired a knowledge of the commercial benefits that arise from this improved system of travelling, and have felt the advantages of it practically, their distaste for the old mode of conveyance has increased; and if railway communication were attainable at a cost at all approximating to that previously employed, it would very shortly become universal throughout the empire. But the general adoption of the railway system followed its introduction so speedily, that many roads were half finished before their expenses could be ascertained; each town capable of raising sufficient capital to connect itself with the metropolis did so immediately,—more eager to be on a par with its neighbor, than considerate of the expense it was about to incur. Fortunately these increased facilities in many cases created a traffic which compensated for the outlay that was found necessary to form and work these roads; and as there is now so large a portion of capital sunk in this description of property, and a moral certainty that a greater number of railways will be made in the next ten years than have been made and partially completed in the last,* any invention tending to facilitate their formation, or to reduce their cost, is a matter of the greatest national and commercial importance: and if by such an invention the speed of travelling can be further increased, the danger of accidents diminished, and the expense of transporting goods reduced to as low a rate as by canals, the traffic, and, as a natural consequence, the remuneration to the proprietors, will be proportionably augmented.

Our object is to point out, that these results will follow the adoption of the atmospheric system of working, and we think it will be admitted that we have fully borne out and justified this idea, when we have taken a review of the nature of the power and the experience already obtained on the one hand, and of the drawbacks under which the present system labors on the other. We will first notice the principal defects in railways worked by locomotive power. These are the expenses consequent upon their formation and working, in addition to the impossibility of obtaining a speed beyond 25 miles an hour, without incurring a more than proportionate additional expense. For an engine that would draw 61·29 tons on a level at the rate of 25 miles an hour, would if required to travel 30 miles an hour, only be able to draw 29·66 tons, or, for the additional 5 miles in speed, a loss of more than one-half in power. These evils arise from the following causes.

First, from the necessity of making the roads comparatively level, owing to the nature of the power employed. The whole power of the locomotive engine is not available to impel the train because it has to drag itself and

* In England alone, since 1831, upwards of 2000 miles of railway have been completed, or are in progress of completion.

tender. Thus a great portion of its power is consumed even on a level; but that loss of power is greatly augmented when contending with the slightest ascent.

The extent of this defect will be more clearly apparent by an example:

Supposing a locomotive engine to possess a gross tractive force of 1700 lbs., and its weight including tender, to be 20 tons, (this is the actual weight and tractive force of the best locomotive engines in general use when travelling at a mean rate of 20 miles per hour,) and as 14 lbs. per ton is required to attain this velocity on a level road, 280 lbs. will be consumed to impel the engine and tender, leaving 1420 lbs. available for the train. This, at 14 lbs. per ton, will draw 101 tons on a level road. We will now place the same train on an inclined plane rising 1 in 50. The power required to draw a ton at the same speed is then increased from 14 lbs. to 59 lbs., or nearly 4¼ times as much as on a level: therefore the engine and tender weighing 20 tons will consume 1180 lbs. instead of 280 lbs., and will leave but 520 lbs. available for the train, instead of 1420 lbs.; but as the train now needs 5959 lbs. to enable it to ascend, 11½ locomotives, each possessing a tractive force of 1700 lbs., together 19,550 lbs., will be required to produce that available force; we thus have an absolute waste of more than two-thirds of the power employed on an ascent of 1 in 50, while on a level it is less than one-sixth. By the same calculation it will be seen, that if the activity be slightly increased, the locomotive engine will not have sufficient power to draw itself and tender, even without the train.

Secondly, by the necessity of having great weight and strength of rails and foundation consequent on the employment of locomotive engines. These engines (exclusive of tender) weigh generally from 14 to 15 tons each; and, in addition to the rigidity of road required to sustain this weight passing over it on one carriage, the motion transferred to the wheels by the engines alternately on each side, causes a continual displacement or forcing out of the rails.

The third, and perhaps the greatest evil, is the heavy expense attendant on working a railway by the ordinary method; and this item is rendered more excessive by the necessity of having a large number of extra engines in store to keep an adequate supply in working order. By reference to the half-yearly accounts of the Liverpool and Manchester railway, the annual expense for locomotive power and coke is found to be from £57,000 to £60,000 a year, nearly £2000 a mile per annum, on a traffic of about 1700 tons a day. This amount is exclusive of first cost and interest on the original stock.

The fourth evil is the large consumption of fuel in proportion to the power obtained, which arises, in part, from the great velocity in the movement of the pistons, preventing the steam from acting on them with full force; which causes a back pressure on the pistons, reducing their force in proportion to the velocity at which they move: the power of the engine is thus constantly diminished as the velocity of the train is increased. To so great an extent is the combined action of these defects felt, that when travelling at 20 miles per hour, the effective power of the engine is reduced to half that which would be obtained from the same quantity of steam generated, and fuel consumed, with a stationary engine. When travelling at 30 miles per hour it is reduced to less than one-fourth; and at a speed but little exceeding 45 miles, the power is so far destroyed that the engine will scarcely draw more than itself and tender. An additional waste of fuel, to an immense extent, is also occasioned by the loss of power (as already shown) on inclined planes. And, lastly, the chances of accident from collision, run-

ning off the rail, bursting of boilers; effects, which have been too severely felt during the past six months.

From the foregoing remarks it will appear that the evils of the present system are entirely attributable to the use of locomotive power, and the remedy must be sought for in the employment of stationary power in its stead: the means by which this can be effected without diminishing the accommodation and advantages at present given to the public, are next to be considered; and it is confidently expected that in the following summary will be found, not only remedies for all existing evils, but also many important advantages, both in speed and safety, which cannot possibly be obtained by the above named system.

1st. The loss of power occasioned by the locomotive engines having to draw their own weight is entirely avoided, and steep hills may be ascended with no more additional power than that actually due to the acclivity, as there is no weight except the train.

There is no other known power which can be applied to locomotion without carrying considerable weight and friction with it. The ill effects of locomotive engines have been already pointed out, and the same disadvantages exist in the application of ropes, which must be drawn along with the train, and become an increased incumbrance on inclined planes. The defects of ropes in other respects are too generally known to need comment.

2d. The weight of the rails and chairs on the new system may be less by one-third than where locomotive engines are employed, as the carriages of the train will be too light to injure them. The annual charge of maintenance of way will, from the same cause, be reduced to a considerable extent.

3d. The wear and tear of locomotive, compared with stationary engines, is as 18 to 1.

4th. By the new system the full power of the engines is always obtained: and on an incline the additional quantity of fuel consumed in ascending will be saved in descending, as the trains run down by their own gravity. The expense of fuel will be further decreased, as the expense of using coal is only half that of coke.

On the new system the velocity depends entirely upon the velocity with which the air is withdrawn from the pipe; therefore, by simply increasing the air pump, any speed may be attained; and with a fixed quantity of traffic per diem, no considerable increase in the fuel consumed or any other expense is incurred for improved speed, further than the small additional power required to overcome the increased atmospheric resistance. An actual saving in the first cost of a railway constructed for high velocities may be effected, because, by performing the journey in less time, a greater number of trains may be despatched each day, and their weight diminished; therefore the piston, having less to draw, may be smaller in diameter. The cost of the pipe (which forms the largest item in the first cost of this railway) will thus be reduced in nearly the same proportion as the speed is increased.

Besides these advantages, this system possesses others of still more importance to the public. *No collision between trains can take place*, for as the power cannot be applied to more than one piston at a time in the same section of pipe, the trains must ever be the length of a section apart from each other; and if from any cause a train should be stopped in the middle of a section, the train which follows it will be obliged to stop also at the entrance of the pipe, as there will be no power to propel it until the first train is out. It is also impossible for two trains to run in opposite directions on the same line, as the power is only applied at one end of each section.

A train cannot get off the rail, as the leading carriage is firmly attached to the piston, which travels *in* the pipe *between* the rails, and the luggage and carriages cannot be burnt, as no engines travel with the trains.

We now come to the comparative cost of the two systems.

1st. The necessity of having the railway comparatively level causes the present enormous outlay for earth work, viaducts and tunnelling, and increases the cost of land, not only by lengthening the line to save cutting and embankment, but by the quantity wasted on each side of the road wherever such work is required. Thus, if an embankment or cutting has to be made of 30 feet, at least 60 feet of land must be covered on each side of the railway in order to obtain sufficient slope, making a width of 120 feet, besides the road, except where they occur in very favorable ground. The comparative expense of this item between the two systems can be ascertained by referring to the average cost of forming a turnpike road and that of the principal railways now in operation.

Since it is not necessary to make detours to avoid steep gradients, the direction of the road in a straight line may be more nearly preserved.

LOCOMOTIVE SYSTEM.	Per mile.
Taking five of the principal railroads as the basis of our calculation, their average expense of formation has exceeded*	£36,000
And the original stock of locomotives,	1,600
	37,600

ATMOSPHERIC SYSTEM.	Per mile.	
The average expense of forming a turnpike road throughout England has been £3000 per mile, but for our road say	4,000	
Allow extra for road bridges,	2,000	
Rails, chairs, sleepers and laying down,	2,500	
Main pipe and apparatus complete (on a scale for transporting 360 tons per hour, or 5000 tons per day of fourteen hours, on a road with gradients of 1 in 100,)	5,200	
Fixed engines, air pumps and engine houses,	1,400	
Travelling pistons,	20	
	15,120	
Saving per mile in forming and furnishing on the atmospheric system,	22,480	
	37,600	

Annual expenses of working per mile, when conveying two thousand tons per day. (This is beyond the average quantity conveyed on the Liverpool and Manchester railroad.)

LOCOMOTIVE SYSTEM.	Per mile.
5 per cent. interest on capital invested, £37,600,	1,880
Maintenance of way,	450
Locomotive department, including coke,	1,800
	4,130

ATMOSPHERIC SYSTEM.	Per mile.
5 per cent. interest on capital invested, viz., £15,120,	756
Maintenance of way, and attendance on mains,	300
Wear and tear of fixed engines, 5 per cent of cost,	70
Coal, 0·75 lb. per ton per mile, 214 tons, at 20s.	214
Wages to engine men and stokers,	60
Wages to train conductors,	26
Renewal of travelling apparatus and composition,	50
Sundries,	150
	1,626
Annual saving per mile on the atmospheric system,	2,504
	4,130

Total expenses per ton per mile on the locomotive system, 1·54d.
Total expenses per ton per mile on the atmospheric system, 0·06d.

Exclusive of carriages and management, which may be taken as the same on both systems.

* Our calculations are founded on the reports of different companies whose railways are complete or in a forward state.

In the comparison which we have instituted between the locomotive and the atmospheric systems, we have not dwelt particularly on many important defects of the locomotive system, but have only noticed them with a view to point out their existence, and to show that the very nature of the system we are advocating, prevents the possibility of their being found in it. We do not think, however, that we should do justice to ourselves if we were not to notice more fully some of the worst of these evils, with the view of ascertaining to what they are attributable, and what hope exists of remedying them. We have no wish, nor unfortunately have we any occasion, to exaggerate the dangers of steam travelling. Not a newspaper but teems with arguments the most cogent, the most appalling, in favor of a change of system. We may be told that these arguments have been listened to; that the attention of the legislature has been called to the subject, and that consequently steps will be taken so as to entirely prevent the recurrence of the deplorable sacrifices of human life. We answer, that it is impossible. The fault is in the system; and no legislative enactments, however stringent, can remedy it. We have no need of assertion to prove this position. The report of the Liverpool and Manchester railway directors, and adopted by the general meeting of railway proprietors, at Birmingham, on the best means of preventing accidents on the lines, has just been published, and we desire no other arguments to support our views than the opinions put forth by these directors, who must be admitted, from their great experience, to be competent judges of the question, and whose interest is too deeply concerned to allow them to exaggerate the evils they comment upon. the following is the substance of their report.

"In considering the subject of the various accidents which have recently taken place on different railways, and the different circumstances connected with each accident, it appears that they are attributable to one or more of the following causes:

"1st. The want or insufficiency of signal lights, giving warning of danger.

"2d. Neglect on the part of enginemen of such signals when given, comprehending a culpable want of care and vigilance in not keeping a good lood-out; and,

"3d. The difficulty of stopping a train when danger is perceived near at hand."

With respect to the first cause the committee are of opinion, "that the printed rules and regulations of this company, which have been brought under the consideration of many other companies, and, as your committee believe, constitute the basis and tenor of their respective regulations, are, on the whole, well calculated to answer the purposes intended. One modification seems desirable, viz: that the red light or the red flag should, in all cases, and under all circumstances, be viewed as a warning against danger."

As to the second point; "the committee can only recommend great care in the selection of active steady men in the first instance. Good wages, and a considerate regard to their comforts so long as they do their duty; accompanied by the strictest discipline, and by uniformly putting in force the provisions of Lord Seymour's act in cases of any neglect of duty or disobedience of orders, hazarding the safety of life or property, although no loss of either should take place."

"With respect to the third point under review, the difficulty of promptly stopping trains when danger is perceived, the most efficient means hitherto employed are immediately to reverse the engine, and put on the tender break. Great care should be taken by the engineers that the reversing gear is of

the most improved construction, not liable to get out of order, and which cannot fail to act when the reversing lever is applied. * * With regard to the numerous proposals of improvements and schemes for the prevention of accidents by mechanical means, if that unceasing vigilance which cannot be too strongly insisted upon on the part of the engine driver should be at any time relaxed, those who have not been long conversant with the practical working of a railway can hardly be aware how many of them have been long since, and under various forms, already tried, and found to be attended with risks and inconveniences more than compensating for any supposed advantage."

The committee strongly deprecate the idea of relieving the engineman from "the responsible charge of his engine" by appointing a "conductor of a higher standing and superior acquirements, whose special business it should be to look out, and under whose orders the engineman should act.

"By introducing another man on the engine you have another pair of eyes to *look out;* but this advantage, if it be one, might be more than countervailed by the divided authority and responsibility which must inevitably take place.

"Jealousy and disunion, it is to be feared, would frequently arise. These would be destructive of confidence in their own resources to the men themselves, and fraught with danger to the whole train. As to the necessity for superior acquirements or professional skill, there is no evidence of a single accident having occurred owing to the want of these qualifications. The desiderata are *constant vigilance* and *presence of mind* in emergencies; and your committee are of opinion that no man, however professionally competent, ought to be trusted with the charge of an engine till he has served an apprenticeship to the business, and has thus become familiar with the rapidity of the locomotive engine and its consequent excitement, *with its severe exposure to the weather*, with the customs and practice of railway operations, and with all the contingencies of locomotive transit regarding police regulations, signals, etc."

Such are the only means recommended by the Liverpool and Manchester railway committee, with a view to get rid of the dangers attendant on this method of travelling; and we really believe that these gentlemen have suggested all that can be done; and if all railway accidents, or the greater number of them, were attributable to carelessness and neglect on the part of the engine drivers, their suggestion would go far to remedy the evil. But here we contend they are greatly mistaken; the fault is in the system, not in the men. It is quite true that the evidence produced at many of the inquests puts beyond doubt the fact, that the necessary signals have on those occasions been made and must have been seen; yet no attention appears to have been paid, and the most disastrous consequences have been the inevitable result. But does it follow that this inattention on the part of the conductor has been the result of *wilful* neglect? Can it be for a moment believed that any man would thus rush headlong into danger, to the almost certain destruction of his own life, and the imminent hazard of those committed to his care? Common sense repudiates the thought. Nothing short of madness could lead to such gross acts of crime and folly. Let us next consider the circumstances under which these accidents occur, and it will be readily seen that they may be accounted for much more satisfactorily. Many alternatives must be rejected before having recourse to the insanity of the engine drivers for an explanation. It will be seen that the question to be discussed is not, have the conductors the *will* to avert the calamities, but have they the POWER?—not whether we are to consider them as suicidal maniacs, but as

the slaughtered victims of a murderous system. Let the impartial reader judge.

Suppose our engine director fully understands the construction and management of his engine; suppose we can answer for his discretion, that he never gets intoxicated, never gets fatigued, never falls asleep while on duty, never leaves his engine while on the line, never "sits down on the seat,"* suppose him uninfluenced by the "excitement of rapid travelling,"† or by the "severe exposure to the weather."‡ Let us suppose that he can readily attend to the working of his engine, and yet keep a good lookout ahead; that he retains his vision perfect under all circumstances; that it is unimpaired by moving rapidly through the air, and is not affected by the clouds of ashes from the chimney. Let us suppose, moreover, that the atmosphere is always clear, that fogs never occur, or that they never prevent him distinguishing the color of a flag or lamp; and, lastly, let us suppose that no curves exist on the line, and that he is consequently enabled to see the signal half a mile ahead of him. Now what is the time, under all these favorable circumstances, allowed to the conductor by the usual speed, to shut off the steam, give the signal for the breaks to be applied, or, if necessary, reverse his engine? *One minute!* But in addition to the above absurd suppositions, we have presumed that the accident by which a train has been stopped has taken place at a station, and that the danger is consequently known; we have presumed that, knowing this danger, the company's servants have hoisted the red flag or lamp. But trains much more frequently break down between stations, where they cannot be expected to be provided with signals: we frequently hear of trains getting on the wrong line and meeting each other. How are they in such cases to be apprised of their danger? If they are enabled to see each other at half a mile, and recognize their dangerous position, yet but *half a minute* must elapse before they come into collision if unchecked? Is it possible that this short space of time can be sufficient for the two engine drivers to think, act, and give their directions for others to act? And if so, can we be certain that the machinery by which the engines are stopped is in proper order to obey these actions of its director? It may be of "the most approved construction," and may have been perfect on commencing the journey; but does it follow that it is so at this particular moment? It is well known that the cost of repairing locomotive engines is about 50 per cent. of the first cost; is the reversing gear, are the valves, breaks, the machinery, in short, now required to act, never among these expensive repairs? Or are we to believe that the accidents by which they are deranged always occur at the stations? No answer is required to these questions. No one, we think, will presume to assert that these parts are excepted from the fatalities which occur to the rest, or that they take place while at rest. The precautions strongly insisted upon in the report relative to this machinery prove that they have been called for. And now we would ask, are we justified in attributing these melancholy occurrences to the folly of the engine driver? Is it not sufficient to see his mutilated corpse stretched before us, but we must accuse him of *felo de se*, and refuse his remains a christian burial, when an accident to the machinery (of the occurrence of which the report indirectly admits the possibility) would at once excuse him? Charity, pity, all the better feelings of humanity, answer in the affirmative.

It will be readily seen that the suppositions we have made in order to give every possible advantage to this system are absurd, for we have assumed

* One of the charges made against the unfortunate Simpson on the inquest.
† Vide report. ‡ Ibid.

humanity to be perfect, materials indestructible, the atmosphere invariable, curved lines straight; yet this is not sufficient: we must still presume that actions require no time for their performance, and that matter is deprived of its *vis inertiæ!* Had we drawn any inference from the facts that sad experience has afforded us to judge from, we should have concluded the danger to be entirely referable to the use of locomotives, huge masses moving at a great and *varying* velocity, and over which the conductor has comparatively no control. To render railway travelling safe, (a method of travelling now so essential to the commercial prosperity of this country,) we must begin by rejecting the locomotive, and substituting in its stead stationary power.

If we have shown, as we hope we have, dispassionately and fairly, that so large a balance of safety is due to the atmospheric system, the large saving of human life and suffering that would result from its adoption ought to be one of its best advocates for public patronage; and in the same proportion that it restored public confidence and appetite for railway travelling, would it benefit the directors and proprietors. Every fatal accident, on whichever railway it has occurred, has been followed by a sensible reduction in the traffic; and this can be a matter of no surprise, when it is recollected that the present traffic possessed by all railways was actually formed by the increased facilities and inducements they held out to travellers over turnpike roads; remove these facilities, and the increased traffic will vanish. No railroad in existence could pay its expenses carrying only such passengers as are actually obliged to travel, and therefore the best policy of railway directors is to induce the public to use their lines by affording them the fullest and best accommodation as regards safety, speed, cheap fares and agreeable travelling. That railway which provides best for the wants and wishes of the public will, and very properly so, become the most patronised; and it is scarcely too much to assert that a very large portion of business will spring up and locate itself along such lines, while others which may at present possess a large traffic will lose what they found to their hand, if, neglecting this course, they lull themselves into the mistaken notion that the monopoly they possess, not the convenience they afford, will guarantee them an equal amount of business.

The first grand object in railway undertakings is to render them a perfectly secure mode of transit—a conveyance by which the most timid may travel without hesitation, without a thought of fear, and of course without an example of ill, arising from the badness of their workings, to refer to: these great works, destined as they are to effect much good to all classes of society, will never be, nor indeed deserve to be, looked upon as a permanent benefit until they have arrived at this point. Precisely as a country flourishes under a well regulated system of police and justice, where the liberty and right of the subject are respected, so will railways flourish as human life in their keeping becomes secure. The high roads of England became more travelled over as the robbers that infested them fell into the hands of justice; and it is a matter of small importance to a person contemplating a journey whether he have to fear falling a prey to the assassin's knife, or losing his life from the collision of two railway trains. The possibility of either would equally prevent the timid from travelling, and the courageous from travelling more than necessity required.

To render the railway system perfectly secure is, then, the first object, and to this end should those who have its prosperity at heart look well. Humanity dictates it, and interest prompts it; and what greater inducements, we would ask, need be urged?

Perhaps the next point, after having arrived at that degree of security required to satisfy the public, is to obtain that system of working which is the most economical. A large portion of the British commercial public have, with that enterprize which characterizes all their actions, embarked large sums of money in establishing railway communications between most of the principal towns in the kingdom. They saw the advantages that were certain to result from such an improved communication, but they did not know, indeed it would have been too much to have expected from them the expense of making and maintaining this communication. They only knew what their engineers told them. Their engineers' estimates in most cases were considerably less than was found necessary for the work, and this, added to the increased annual expense of working (above that originially contemplated when most of the present lines were projected,) has placed these undertakings in a very questionable light as commercial speculations and permanent investments. If we show this to be the present position of most railways, which we intend doing by reference to their own accounts, we wish it to be understood that we do not from this circumstance draw a conclusion that they cannot be made a lucrative investment. On the contrary, we are of opinion that they can: we think it has been clearly shown that all their difficulties have arisen and are perpetuated by the use of an improper system of working. So long as the locomotive system is adhered to, a strict economy may in a small degree lessen the expenses, but no material improvement can be hoped or obtained. To strike at the root of the evil, the system must be abolished; anything short of this will not be productive of benefits on a sufficiently extensive scale to enable railways to maintain their present position, and yield a return for the millions they have cost. A better instance of this fact can scarcely be needed than an inspection of the receipts and expenditure of those railways already in operation. From the official weekly returns in the "Railway Times," we perceive *seventeen* railways are in operation the whole of their length, and out of the whole number only *three* are earning sufficient to pay their subscribers more than common interest for their money. Of the remaining fourteen, *six* are not taking as much for their *gross* receipts as the interest of their capital embarked, *independent* of working expenses; and the receipts on the remaining *eight*, after deducting the working expenses, do not leave £5 per cent. dividend for their subscribers.

Fifty millions sterling have been embarked in railway speculations, and seventeen lines have come into full working activity, of which number only *three* can show a return beyond common interest to the subscribers: it well behoves capitalists to ascertain the cause of their disappointments, and to seek to recover some of the golden harvests they were led to expect, and which have melted away before their eyes like ice in the rays of the sun. Anything short of perfect indifference to their own interest will force on them the conclusion that they must no longer shut out the idea of improving, and listen only to the counsel and advice of those at present in their confidence, whose interests are served by maintaining things as they now are, and by clinging to preconceptions and prejudices as part and parcel of their existence. When looking over the half yearly accounts of a railway worked by locomotive power, common sense and observation cannot fail to lead to the conclusion, that a very large portion of what would be profits is absorbed by the nature of the power applied; but although a cursory notice of the accounts would prompt this conclusion, few would imagine, without giving the matter very close attention, how great this portion is. Some idea of it may be drawn from the following facts. Each train on railways

is drawn by an engine, the average weight of which is 20 tons; therefore 20 tons carried with each train is perfectly useless. On the London and Birmingham railway the lowest charge for goods is £2 per ton for the whole 112 miles. Supposing, for the sake of argument, the expense of maintaining and working the locomotive department to remain unaltered, but the engines to weigh nothing; it is clear that the company would be able to transport 20 tons more with each train for the same cost, or 15 tons of profitable merchandize, after deducting one-fourth for the wagons, which at £2 per ton would add to their revenue £30 per journey, or, with their present number of trains, (12 each way daily)—£306,000 a year. No doubt this fact will take many railway proprietors by surprise, who by a natural course of reasoning will immediately seek to discover by what means so large an amount, at present wasted, can be made to find its way into their pockets. The means are obvious; the waste is occasioned by transporting useless weight; remove the useless weight, and the objection ceases of itself. Before the introduction of the atmospheric system, it was hopeless, by any known mechanical means, to effect this: every previous application of power carried considerable useless weight with it. The atmospheric is entirely free from this objection; and it was mainly from a knowledge of the benefits that must result from this source that we have labored so incessantly (and happily with such success) to mature and bring it before the public, for their consideration and approbation.

Such would be the effect of dismissing only the *useless weight;* but add to this the other advantage possessed by the atmospheric system, and the London and Birmingham railway (notwithstanding its present large capital sunk) would be enabled *to carry passengers at* 5*s. each, and goods at* 6*s.* 3*d. per ton, the whole* 112 *miles, and share the same dividend as now.*

The calculations from which this statement is adduced are shown as follows: viz.*

	Per day.	Per year.
2500 persons at 5*s.* each,	£ 625	
5930 tons merchandize at 6*s.* 3*d.* per ton,	1,853	
	£2,478	—£805,350
Expenses, viz:		
Coals, 38 stations × 500 lbs. per hour × 16 hours per day = 6867 tons per year at 10*s.* per ton,	£ 3,434	
76 engine drivers at £100 per year, £7,600		
76 stokers at £50 per year, 3,800		
Repairs to engines, oil and tallow, at £70 each × 38, 2,660—	14,060	
Renewal of travelling apparatus, composition, charcoal, etc., £100 per mile × 112,	11,200	
Maintenance of way and attendance to main £300 per mile,	33,600	
Police, coaching, wagons, etc., (as on locomotive lines),	80,604	
General charges, (as on locomotive lines),	15,400	
Parish rates, (as on locomotive lines),	14,400	
Add 5 per cent. interest on £1,500,000, the total amount required to furnish the atmospheric apparatus on a scale for transporting 9600 tons per day,	75,000—	247,698
Balance,		£557,652

* This estimate of traffic is of course much greater than at present exists on the line, but considerably less than the reduced prices would produce; it is scarcely necessary to add, that at these rates any extent of traffic could be obtained in coals and iron alone, as it is less than a sea borne freight from the north.

	Per day.	Per year.
By reference to the last general meeting of the London and Birmingham railway company, (see "Railway Times," 13th February, 1841,) the present receipts average per year,	£810,000	
And the present expenses,	260,000	
Balance,		£550,000

The present charges are,

For passengers, (average), 25*s.* each.

Lowest charge for merchandize, 40*s.* per ton.

We have already shown the expense of formation in railways to be greatly influenced by a portion of the power employed being unavailable, and that the road is levelled as a convenience for the propelling power, not the traffic conveyed. We have also shown that the destruction to the road is attributable to the weights and shocks of the engines, not of the trains; that the enormous expense of locomotive power and coke arises from the bad application of power and the artificial means employed to work engines at an unnatural speed. In other words, all the expenses have been traced home to the use of locomotive engines, which have, from the opening of railways for passenger traffic to the present day, been a source of continual annoyance and vexation; breakage after breakage has occurred, and been succeeded by increasing the weight and power of the machines; this in turn has led to the necessity of increasing the strength and stability of the rails and foundations on which they travel, and increasing the strength of the passenger carriages, to resist any shocks they may occasionally receive from their ponderous neighbor; until we have arrived at this conclusion, that on an iron railroad, where the surface is by comparison smooth and the track marked out, a carriage to convey eighteen passengers must weigh about 3 tons, while over a rough paved road an omnibus weighing only 1 ton will perform the same amount of duty. Here are facts which must at once convince every one that there are in the present system, radical defects to be weeded out: if no remedy were suggested, it might be difficult for railway companies to determine how to extricate themselves from their present position; but under existing circumstances their position is by no means a difficult one. The atmospheric railway has been tested by actual operation at the entire expense of the inventors and their friends. The public have not been asked to support it, or even encourage it, until it has been clearly proved beyond all doubt to merit confidence from its general usefulness. It has claims to notice both in a national and commercial point of view; for while it will afford the means of railway communication to second and third rate towns by the small outlay necessary for the formation and working, it will enable the proprietors of railway enterprizes already established or in course of formation, to realize that return for their capital which they so richly deserve, and which, under the present system, they so hopelessly look for.

The length of the foregoing treatise, prevents us from giving, as we promised and intended, in this number, the examination of Messrs. Gibbons, Cubit, Brunel and Stephenson, before the committee of the house of commons. We shall, however, continue the subject in our next, and at considerable length, that it may be properly understood in this country, at least as far as it can be from the experience of those who have examined, studied and tested it. In giving thus fully the views of the patentees, and those

who have experimented upon it, we have but *one* object in view, and that is to bring the matter fairly before the railroad community that it may be understood, and if found to possess advantages over the present system, adopted; but if not, then let us stand by the "*iron horse*" which has already accomplished so much.

To succeed and come into general use, it has yet to overcome a powerful opposition, not greater however, than the locomotive has already overcome; we therefore have no anxiety in relation to it, as there is likely to be a thorough and probably fair trial of it on the Epsom road, after which, *opinion* or *theory* will give place to *fact*, and the system will be either sustained or exploded; although we do not agree with the "North American" that it has already "exploded" as there are quite as good opinions in its favor,—Mr. Cubit's, Mr. Brunel's and Mr. Gibbon's—as Mr. Stephenson's against it, as we will show in our next.

GEORGIA RAILROAD AND BANIKNG COMPANY.

We are indebted to J. E. Thompson, Esq., chief engineer, for a copy of their last report, giving a statement of their progress to April last, from which we learn that the work is progressing steadily, but surely, to completion. In 1837 forty miles of this road was brought into use; in 1838 it was extended to 75 miles; in 1839 to 88 miles; in 1840 to 105 miles, and in 1841 to 147½ miles. The total receipts for passengers and freight are given as $1,233,887 00, its total expenses $528,168 00 and its net profits $705,719 00. The rates were considerably reduced last year, and the business increased nearly 33 per cent., and the net profits are nearly $10,000 greater for 1843 than for the previous year, thus showing in an eminent degree, the correctness of the policy of putting the charges at rates which will *increase*, rather than prevent or divert in other channels the business of the region through which railroads pass. It is worthy of remark, that with an increase of business of over 30 per cent. in 1843, the expenses of the road were less by $9,246 than in 1842. The net profits exceed *six per cent.* on the cost of the road, including its branches and machinery, which is certainly encouraging to those interested, to push on the work as rapidly as possible; and it encourages us to look forward, with increasing confidence to its connection with other interests and other roads, until it rests one foot on the Mississippi and the other on the gulf of Mexico, with its outlet on the Atlantic.

ENGINEER'S REPORT.

To the Hon. John P King, president of the Georgia railroad and banking company.

SIR:—I have the pleasure to communicate to you the proceedings of this department for the year ending on the 31st of March.

Active operations upon the extension were commenced between Madison and Covington about fifteen months since. From the nature of the contracts entered into, the work has necessarily progressed but slowly. Yet we have every reason to believe, that the whole of the grading and masonry then contracted for—much of it quite heavy—will be finished by the first of July

next, except probably a rock section which may not be completed until August. In consequence of the uncertainty which rested over the extension of our road, even to Covington, the wood work of the bridges, from its perishable character, was not contracted for until the general letting in November last, at which time it was thought that if immediately commenced, it could be finished as soon as the grading. The subsequent demand for labor, and consequent rise in its price, has however, materially interfered with the execution of the timber contracts, which together with the failure of the Nisbet iron works to supply the bridge irons required, has greatly retarded the progress of the work, and I fear, will prevent us from reaching Covington as early as we had desired.

As soon as practicable after the means necessary for the continuation of the road to the southeastern terminus of the State work had been obtained, the grading and bridging of the whole line was placed under contract. The work was let upon very favorable terms, but from causes already referred to, it has not progressed with that spirit which we had expected. Since the late decline in the staple of the country, labor has become more abundant, and the work is now advancing with renewed vigor. From our present prospects, it is believed that the whole line, with some immaterial exceptions will be ready by the first of February next for the reception of the superstructure. While we cannot calculate with certainty the precise time we shall reach Covington, yet we may safely place the completion of the entire road to the State terminus at not later than September, 1845.

The following is a revised estimate of the cost of the road from Madison to the southeast terminus of the Western and Atlantic railroad, a distance of 67 4/10 miles.

Graduation, including culverts.			
From Madison to Rutledge's, 8·8 miles,	$26,500 00		
" Rutledge's to Social Circle, 7·3 miles,	27,800 00		
" Social Circle to Covington, 10·4 miles,	87,400 00		
" Covington to Holcomb's, 10·5 miles,	51,800 00		
" Holcomb's to Stone Mountain Depot, 15·0,	43,100 00		
" Stone Mountain to Marthaville, 15·4 miles,	71,600 00—		308,200 00
Bridging.			
Alcovy bridge and truss work, 1400 feet,	20,600 00		
Cornish creek bridge, 610 "	4,900 00		
Wood's mill bridge, 470 "	4.700 00		
Dried Indian creek bridge, 900 "	4,600 00		
Turkey creek bridge, 370 "	1,800 00		
Yellow river bridge and approaches, 490 "	12,800 00		
Sundry small railway and road bridges,	3,300 00--		52,700 00
Superstructure.			
Mud sills for main line and turnouts, 69 miles,	20,700 00		
Cross ties " " "	28,900 00		
Wooden rail or stringers, " "	29,800 00		
Iron (exclusive of duty) at $45 per ton, "	185,000 00		
Cast iron chairs and washers, "	11,000 00		
Screws, spikes and bolts, "	19,000 00		
Laying superstructure and contingencies, "	48,000 00--		342,400 00
Right of way, - - -	18,000 00		
Real estate to be retained for use of road, -	12,000 00		
Engineering, etc., - - -	33,000 00		
Depots, wells, pumps, tanks and division houses,	18,000 00—		81,000 00
Total cost of road,			$784,300 00

Equal to $11,366 per mile for the length of single road, or $11,636 per mile for the distance between Madison and Marthaville; which, if the whole had been executed at the present low cash rates, could have been done for about $1000 per mile less.

* * *

The receipts of the road for this year, have exceeded those of last year only $69 50, while the gross tonnage has been increased fully 33 per cent. On the down freight, the receipts have fallen off $6,173 80, and the passage money has increased $6,290 08—the up freight remaining nearly stationary. It will be recollected, however, that we received last year about $12,000 for the transportation of iron, spikes, etc., for the Western and Atlantic railroad, which should not be counted in the general business of the country. By deducting this amount from the receipts of that year, we have the increase of the receipts of this year, about equal to those of last year over the year previous.

The reduction in our rates was probably greater than succeeding circumstances have justified; especially as they have not been met by corresponding concessions on the part of our neighbors on the other side of the Savannah, except upon such articles as they are competitors with the steamboats for. But as there has been no diminution in our receipts, and notwithstanding the increased tonnage transported, the expenses of the road have fallen short of those of last year. We are not disposed, from these causes, as well as a disinclination to frequent changes, to make any material variation in our tariff.

Having failed in our efforts to form a satisfactory ticket at a reduced rate, for the travel going through from Baltimore to Montgomery, we have been content to confine ourselves to a ticket from Montgomery to Charleston—between which points passengers are now carried in less than two and a half days, for $26 50, by railroad and stages.

We have also, in conformity with a resolution of the board, carried out the suggestion referred to in my report of last year, in relation to planters accompanying their produce to market at a reduced rate. The system, as far as we can judge of its effects, seems to have operated alike beneficial to the company and planters, and is at least worthy of a longer trial.

The business of the road, and the expenses incurred in working it, during the year ending on the 31st ultimo, are shown in the following summary statement. The usual detailed statements of the several accounts, will be found among the accompanying papers.

CR.

By amount received for passengers up		$34,005 20	
" " " down		31,660 83	
" " extra trips, extra baggage, negroes, etc.		3,664 86	
" " freight up		69,661 19	
" " " down		78,400 26	
" " " between stations		388 52	
" " rents		809 66	
" " United States mail		29,246 97	$248,096 44

DR.

For expenses of conducting transportation		$26,902 61	
" " motive power		25,838 29	
" " maintenance of way,		38,156 97	
" " " cars		9,675 45	$100,573 32
Leaving net profit			$147,523 12

Over six per cent on the cost of the road, including the branches machinery, etc.

The expenses of the road have, for reasons given in my last annual report, fallen below those of last year. For the next year mainly from opposite causes, they will be somewhat higher.

The efficiency of our motive power has been so materially increased, that although we have had a larger tonnage than usual, and had disposed of one of our original stock of engines, we have still been able to do the business with regularity, without calling into service two of the remaining number. This improvement is mainly to be attributed to the alteration of the Tennessee, to Messrs. Baldwin and Whitney's improved freight engine, referred to in a former communication. This engine having been the first of the kind made, we had to encounter the risk of a failure in some of the details of its construction—the subsequent occurrence of which, as anticipated, prevented us from deriving any benefit from the services of the machine until last fall. We have since given it ample trial, and have become as fully satisfied with its practical performance, as we had previously been with the principles upon which it was built. As soon as we had fully tested this machine, we ordered in accordance with our original intention, a small engine of similar make, for the Athens branch, to be delivered this spring. We are informed however, by the manufacturers, that upon putting it together, its weight greatly exceeded our limits, and in consequence, we have been compelled to reject it, and wait until another can be completed.

The number of miles run by all our engines, during the year, is 153,125, of which 87,200 miles was by the regular passenger trains, on the main line and Athens branch, carrying also some freight. The net amount of freight hauled by all the trains one mile, is about 1,300,000 tons, exclusive of materials for the road. The expenses of the motive power department are $25,838 24, or 16 $\frac{8}{10}$ cents per mile run by the engines. The repairs of the engines and tenders, and the cost of fuel, are each 3 $\frac{7}{10}$ cents per mile run. The whole expense of the road is 65$\frac{1}{2}$ cents per mile run by the trains. The cost of maintaining the road is, this year, $260 per mile or nearly 25 cents per mile run by the trains.

IRON REVENUE STEAMER ON LAKE ERIE.

We have been politely furnished with the following statement in relation to the iron revenue steamer on lake Erie, built by Messrs. Stillmam, Allen & Co., of this city, for the United States revenue service. Length of keel 144 feet, breadth of beam 23 feet, depth of hold 12 feet; keel 1 foot in depth of $\frac{1}{2}$ inch iron; ribs or frame 4$\frac{1}{2} \times \frac{3}{4}$ inch; plating of bottom $\frac{3}{8}$ inch.—Rigged with three masts, having a pair of Capt. Hunter's submerged wheels. Weight of iron about 125 tons. This ship was put up in the ship house of Stillman, Allen & Co., taken down in sections of convenient size for shipment, and sent to Buffalo, where she is now rapidly going on to completion. She is one of four of the same class now building under the direction of Capt. Wm. A. Howard. The engines for this vessel are being made at the "Buffalo steam engine works," according to the direction of Capt. Hunter, but of their capacity we are not informed.

☞ Will the chief engineer of the Baltimore and Ohio railroad please answer the following enquiry?

June 26.

Mr. Editor: To decide a discussion, will you be so kind as to furnish a reply to the following query, in the next number of your Journal, or whenever it is convenient to you: or call upon a correspondent well informed of

the facts, for an answer?—What was the actual cost of the depot and car house at Baltimore? I am anxious to get a certain estimate, and your attention to this request will be considered a real favor. Respectfully your's,

A Friend to Internal Improvements.

DELAWARE BREAKWATER.

Major Bache, United States engineer, says, in his report to the secretary of war, dated October 15th, 1843,

"Since the session of 1837 and 1838, no appropriation has been made to continue the construction of the Delaware breakwater, and the last stone provided by that appropriation was deposited in 1839. * *

"The following table shows the number of days' shelter afforded to vessels by the Delaware breakwater, from the 1st of September, 1833, to the 30th of September, 1843, inclusive—omitting the periods embraced between the 1st of July and the 17th of October, 1834; and the 4th of June, 1840, and the 30th of April, 1841, (when no record was kept); and also omitting vessels carrying stone, or otherwise connected with the work.

Years.	Ships.	Brigs.	Schooners.	Sloops.	Pilot boats.	Total.	Remarks.
1833	22	178	372	167	127	866	From Sept. 1st, inclusive.
1834	48	315	667	303	411	1,744	July 1st to October 17th, inclusive, not recorded.
1835	133	569	1,719	461	644	3,526	
1836	301	1,027	2,719	620	767	5,433	
1837	227	478	2,777	629	732	4,843	
1838	165	732	3,191	765	685	5,538	
1839	165	504	3,561	734	697	5,661	
1840	172	279	1,909	308	371	3,039	To June 3d, inclusive.
1841	111	902	3,916	590	483	6,002	From May 1st, inclusive.
1842	107	1,060	5,335	802	794	8,098	
1843	84	644	3,865	962	572	6,127	To Sept. 30th, inclusive.
	1,535	6,688	30,031	6,341	6,283	50,878	

"Making a just allowance for the periods when no records were kept, it may be safely said, that from its commencement to the present time, the harbor has given sixty thousand days' shelter. According to the record for the last four years, twenty-two vessels on an average, had been lying in the harbor for each day. Sixty to seventy vessels are seen frequently lying in the harbor at the same time, and on one occasion the number of vessels reached as high as one hundred and eight. * * * *

"These works have not yet been completed to the extent of the design thus briefly described. The breakwater is in a course of construction for 862 yards, and the ice breaker for 467 yards. In other respects, the design of the harbor is necessarily incomplete. The entrances at the cape, and between the two works, are 780 yards, and 455 yards, respectively, instead of 500 yards and 350 yards, as at first contemplated. It would thus appear that on the one hand the breakwater proper is 338 yards, and the ice breaker 33 yards, less; and on the other, that the entrance towards the sea is 280 yards, and that between the works 105 yards, greater than the plan called for. In short, the lines of protection are less, and the entrances greater, by the quantities just given, than were originally designed. * *

"It is believed that no plan has been devised to correct the evils in the harbor caused by running ice. One is incidentally alluded to in the annual

report of 1836, and the imperfection of it is clearly demonstrated. Any structure on the course of the current would not afford protection against running ice; and one of stone across the current would, by impeding it, create shoals that would injure if not destroy the harbor. The great desideratum is, to be able to obstruct the ice without obstructing the free course of the current. In order to accomplish this result, the application of the iron screw pile has been suggested in former reports These piles, it is conceived, may be so combined as to constitute a complete barrier against the passage of the floating ice, at the same time that the current is allowed to flow in its accustomed course, and with the same velocity. It is, in all respects, worthy of consideration, whether a fair experiment, conducted with liberal means, ought not to be made, in order to ascertain clearly whether the iron screw pile may not be successfully applied to this purpose. The result, if favorable, would constitute an epoch in the construction of ice harbors, and would lead to kindred applications of much importance. It is with a view to such an experiment, that an item for iron screw piles is included in the estimate of the operations for the next season. In using such piles in the formation of an ice harbor, they may either form a continuous work, composed of rows in quincunx order, or constitute piers at certain intervals, as may be deemed advisable, after proper investigations. Under any form of combination, the piles should be braced horizontally, by bars of iron, at low water and at the top, in order that the shock caused by the ice may be sustained, not by one pile, but by numerous contiguous piles. In adopting the work just described as a remedy for the defect in the harbor of the Delaware breakwater, arising from running ice, it should commence at the west end of the ice breaker, and extend towards the shore, on the shortest line, until the required protection is gained."

BEAR MOUNTAIN RAILROAD.

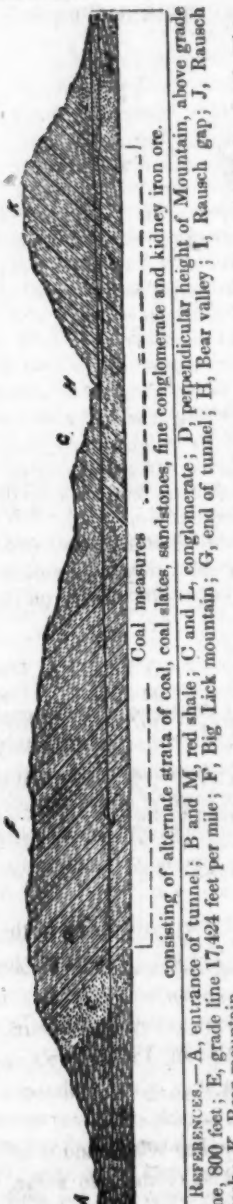
This road penetrates one of the richest and most extensive anthracite coal fields in the State. The Bear valley coal basin, which will be immediately opened by this road, comprises the southwestern termination of the great coal field surrounding the town of Pottsville. This basin is about thirteen miles in length, varying from two to three miles in breadth and the average breast of the coal veins above water level in the two mountains forming the sides of the basin, is over one thousand feet.

All the varieties of anthracite coal, red, white and grey ash, found in the Pottsville region, are found here, and the quality is in every respect of the most superior kind.

Prof. Walter R. Johnson, in his report on the Bear valley coal district, states that this coal bears a stronger analogy to that of Yniscedwyn in Wales, used in Crane's celebrated iron works, than any other anthracite coal in Pennsylvania.

Iron ore also in abundance and of excellent quality, has been found intervening the coal veins. The coal veins run lengthwise of the two mountains throughout their whole extent, and dip in each mountain under the enclosed valley, at an angle of about forty-five degrees. They are found alternating with coal slates and large strata of sand stone and conglomerate rock, interspersed with occasional layers of iron ore. The annexed dia-

gram exhibits a cross section of these mountains and the position of the coal veins.



REFERENCES.—A, entrance of tunnel; B and M, red shale; C and L, conglomerate; D, perpendicular height of Mountain, above grade line, 800 feet; E, grade line 17,424 feet per mile; F, Big Lick mountain; G, end of tunnel; H, Bear valley; I, Rausch gap; J, Rausch creek; K, Bear mountain.

The north, or Bear mountain is cut to its base by Rausch creek, forming a gap, on each side of which, all the veins can be opened; and the south or Big Lick mountain will be penetrated by the railroad tunnel directly opposite Rausch gap, thus opening all the veins in that mountain in the same manner.

By this means every coal vein in the entire region will be opened in the most advantageous manner for working. It is confidently believed that no other coal region in the world is possessed of equal advantages.

The height of the mountains above the tunnel, and above the grade line of the road in the gap, is about eight hundred feet, consequently the breast of coal in the veins outcropping at the summits of the mountains is over eleven hundred feet. The tunnel will cut across at least fifty veins of good coal varying in thickness from four to thirty feet, and besides these there are not less than thirty veins of similar thickness in Rausch gap.

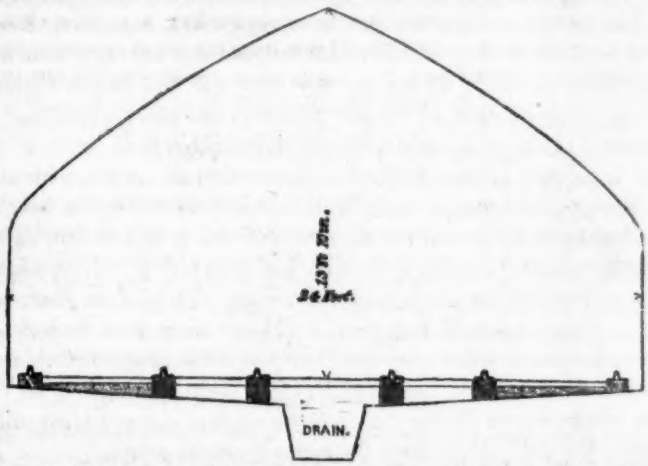
From this it will be perceived that even if the whole supply of coal for the United States, was to be obtained from this region for centuries to come, it would not be necessary to mine below water level and consequently the enormous outlays for machinery, and constant expense necessary to raise coal from below water level, will in this region be entirely avoided.

The railroad tunnel through the southern coal mountain will be about one and a half miles in length, and of sufficient width for three tracks, the centre track being intended for the use of locomotives and through trains, and the side tracks for coal cars only.

It will require about 750 lineal yards of this tunnel from the south end driven through solid rock to reach the outside coal vein, and the remaining distance will be through coal, coal slates, sandstones, conglomerate and iron ore. It is intended to drive about 800 lineal yards of this tunnel by the time the road is ready for business, leaving the remaining portion of the tunnel to be driven after the road goes into operation. The tunnel will be cut on a grade descending towards the canal at the same rate as the other portion of the road, viz. 17½ feet per mile, and when the tunnel is completed, the road will be extended on the same grade through Rausch gap.

The form and dimensions of this tunnel are shown in the following sectional drawing.

SECTION OF TUNNEL THROUGH BIG LICK MOUNTAIN.



From the termination of the road on the Pennsylvania canal at Dauphin to tide water at Havre-de-Grace is eighty miles. The canal from Dauphin to Columbia is of the same capacity as the Erie canal, capable of passing boats of from seventy-five to eighty tons burthen, and the Tide Water canal from Columbia to Havre-de-Grace is of still greater capacity. Havre-de-Grace being at the head of Chesapeake bay, the Atlantic coast can be reached from this place, more readily than from any other point where anthracite coal is shipped, unless it be Delaware city, and to this point the coal can be transported in the same boats used on the canal.

It is not the least recommendation of the Bear valley coal region, that it will have a very large home consumption, without coming into competition with the coal from any other region, and as the Bear mountain railroad will be the only means of transportation from these mines, it may perhaps escape the effects of "incendiary publications."

The coal from the Bear valley region will have the entire command of the trade south and west of the mines, including the cities of Lancaster, Baltimore, Washington, the Boroughs of Harrisburg, Columbia, York, Chambersburg, Carlisle, Hagerstown and the adjacent country, with its extensive iron and other manufacturing establishments and consequently must have a certain trade of nearly 300,000 tons per annum, before coming into competition with coal from other districts. When in addition to this we take into account its proximity to the seaboard, the favorable character of its avenues to market, and the low price at which it can be delivered in the Atlantic cities, there cannot be a doubt but that this coal basin and the railroad leading to it will yet eclipse all their cotemporaries in the magnitude of their operations.

IRA SPAULDING,

Dauphin, Pa., July 1844. *Chief Engineer, B. M. Railroad.*

We published in our June number a letter from Ira Spaulding, Esq., chief engineer of this road, showing that a new route had been discovered far more favorable than the one formerly contemplated through Lykins valley. It will be seen by reference to that letter, (page 171, June No.), that a saving of 14 miles in distance will be effected, and that instead of from a level to a maximum grade of 36 feet per mile, they will now have a *regular descending grade* of about 17 feet per mile from the *heart of the coal veins* to the canal at Dauphin, eight miles above Harrisburg.

We now give a further account of this remarkable work, with illustrations, showing the position of the coal bed, and the manner in which it is perforated by the railroad tunnel, of a mile and a half in length, which passes through at least fifty veins of coal, of from four to thirty feet in thickness, at a thousand feet below their outcropping. A position more favorable for working, it would seem to us, could not have been devised by the most ingenious and selfish man—as it may be led in shutes directly into the cars—and the road itself, having 17 feet fall, forms an ample drain to lead off the water—thus avoiding the immense expense at many other collieries, of raising the coal and draining the mines by steam power.

We desire to make our acknowledgments to Messrs. Spaulding and Sickles for their remembrance of the Railroad Journal, in laying the merits of their work before the public. We hope to hear from them again soon in relation to their progress.

UTILITY OF WIRE ROPES.

The following statement, from the London Mining Journal, in relation to the use of wire ropes for coal mines, may be useful to those in this country requiring ropes for such purposes, or for inclined planes, as well as our worthy friend, Mr. John A. Roebling, of Saxonburg, Pa., who is engaged in the manufacture, as will be seen by reference to the Journal of November last—therefore we transfer it to our pages.

"The question of the comparative strength of hemp and wire ropes used in the 'winning' of coal, and, indeed, for every other purpose for which rope is applicable, having been frequently discussed in our columns, we have pleasure in complying with the request of a correspondent, by inserting the following communication, addressed to Mr. Newall, manufacturer of wire rope, by so distinguished a colliery reviewer as Mr. Matthew Liddell, dated from Benton Grange:

"'Dear Sir—I consider the following information may be interesting, and certainly goes far to establish confidence in the equal security of flat wire ropes with those made from hemp, when exposed to a sudden violent strain; which, it has been stated, would cause the former to snap, or break. On Monday, last, when employed in drawing coals, the breaksman of the engine, (46 horse power) on which a pair of your flat wire ropes were put in June last, neglected to check the engine on the approach of the cage and tubs to the surface; and, consequently, the engine continued at full speed, (the rope moving about 120 fathoms a minute), until suddenly stopped by the cage coming into violent contact with the pulley. The shock slightly displaced the pulley frame, when the rivets of the shackle which you attach

to the end of the rope where the cage is hung on to it, were drawn through the strands of the rope, and the cage and coals fell on the 'keeps' at the top of the pit, which prevented their falling down the pit, so that the damage done was trifling. I have since then had the wire rope examined, and, although the strain on it must have been very great to stop the engine, yet it does not appear to have sustained any injury, and is, apparently, as good as when it was first put on. MATTHEW LIDDELL.'"

SAULT DE ST. MARIE CANAL, AND ST. JOSEPHS RAILROAD.

We have received, since our July number was put to press, a communication from the Hon. Mr. Woodbridge, of Michigan, in relation to the defeat of the bills before congress in aid of these important works, accompanied with various documents of interest, in relation to the Canadian canals and plank roads, together with the annual report of the board of internal improvement, of Michigan, for which we desire to tender him our thanks. We shall avail ourselves of their use, and then dispose of them in accordance with his directions.

HUNT'S MERCHANTS' MAGAZINE.

This popular and useful work was punctually on our table, and is, as usual, filled with useful information for the business man; and it should be on the desk of every merchant in the Union, and be read attentively by every clerk, as well as merchant.

PARSONS' LOCOMOTIVE EXPANSIVE APPARATUS.

The following communication from Horatio Allen, Esq., copied from the Franklin Journal, exposes one of the numerous *piracies* perpetrated by designing knaves upon ingenious inventors.

"SIRS—The March number of the Journal of the Franklin Institute contains a description of 'Parsons' locomotive expansive apparatus.' That part of the arrangement which provides an adjustable cut-off, by the use of two slide valves attached to the same rod, one by right handed, the other by left handed, screws, and the mode, adjustment, etc., are precisely those for which I obtained letters patent in August, 1841. The American Repertory for December, 1841, contained a part of my specification and claim.

"The patent of Mr. Parsons is dated December, 1842, and was enrolled in June, 1843.

"The 'adjustable cut-off,' as my invention is named, has been adopted on an engine lately put to work on the railroad from Jersey City to New Brunswick, to one on the Long Island road, and to engines building for the Patterson road, and for the Stonington road.

"I intend soon to send you accounts of the performance of these engines, which have been very satisfactory, and shall also furnish a full description of the combinations embraced in my patent. Yours respectfully,

"*New York, May* 14, 1844. HORATIO ALLEN."

Mode of Folating Large Stones for Building Sea Walls in Deep Water.—At the meeting of the institute of civil engineers of the 12th March, Mr. Bremner read a paper describing the casks used for floating the large stones for securing the foot of the sea wall of Banff harbor, which had failed. The casks were strongly built of fir staves, hooped externally with iron, and supported inside by radiating bars like the spokes of a wheel. Two of

these casks, of 445 cubic feet capacity each, were use to convey stones of 30 tons weight, by passing two chain cables, which were wound round them, through the eyes of the lewises, which were fixed in the stone at low water, at which time the chains being hauled down tight, when the tide flowed, the buoyancy of the casks floated the stones, and they were towed by a boat over the place where the stone was intended to be deposited. The lashing being then cut away, the stone fell into its seat. This method was found to succeed in weather that would have destroyed any crane barges; and the works of Banff harbor were thus secured from further degradation, and were subsequently restored at a comparatively small cost.

Mode of making Looking-glasses, Mirrors, etc., without Mercury.—A correspondent (J. B. N.) sends us the following particulars of a process by which looking glasses, etc. may be silvered in the most effectual way without the use of mercury; he has done several; "the most splendid mirrors imaginable." The following is his account of the process:—"Take a little nitrate of silver; add carefully liquid ammonia till the precipitate formed is nearly all dissolved, but not fully; add a little of this to a mixture of alcohol and oil of cassia; the piece of glass to be silvered is laid flat, with a ledging tied round of pipe clay or the like, exactly as if a mould were to be taken; upon the glass pour the above named mixture till it has a depth of between a quarter and half an inch; then drop here and there upon this a mixture of oil of cloves and alcohol; a violent action takes place where the drops fall; this rapidly spreads, and the whole surface, in the course of from a quarter to half an hour, appears brown; the liquid is now poured off, and a layer of silver is found reduced upon the surface of the glass, forming a complete and beautiful mirror ready to be framed. The chemical action is no doubt the formation of aldehyde which reduces the silver. This process has recently been made the subject of a patent, for which, I am told, the firm of Rothschild has offered £100,000 for the purpose of suppressing the discovery, as it may affect the valuable monopoly in mercury possessed by that house. The offer has been refused. The name of the patentee, I am informed, is Durant, of Brighton." The process of silvering by means of aldehyde was exhibited two years ago at the Glasgow Philosophical Society, by Dr. Stenhouse.

Scaffolding.—Two papers on this subject were read at the same meeting of the Institution. The first paper was read by Mr. T. Grissell, in which the author described the scaffolding first used by Mr. Cubitt for the erection of the facade of the Birmingham railway station, and which had since been adopted for other works with complete success. It was stated to be composed of sills, uprights, cross-heads, longitudinal timbers, braces and struts, all of whole timber. The upright timbers were slightly turned into the horizontal timbers with junctions secured by iron dogs, driven into the timbers diagonally across the joints, which were preferable to bolts and spikes, inasmuch as they could be easily withdrawn, and the timber was not injured. The next paper on the subject was by M. Pierre Journet, whose scaffolding was stated to consist of a simple combination of a number of brackets, fixed at regular distances of about five feet apart vertically, upon girdles of chains and screws, braced tight round the column under repair: upon these brackets the platforms were laid, and as the workmen proceeded upwards, the lower brackets were alternately raised to the platforms above, where the workmen stood. The progress thus made in forming, and in taking down a scaffold, was stated to be very rapid, with corresponding economy of time and expense; no poles or cords were used and no waste of material occurred. By these means the obelisk of Luxor, at Paris, was repaired in a very short time and at a very small cost. The machine for raising building materials consisted of an endless chain of square open links, the lower end revolving around a driven wheel, and the upper end around a corresponding wheel, fixed upon a scaffold, at the height of the building. The hods, buckets and baskets were each furnished with a hook by which they were suspended on the rising side of the chain, and when they arrived at the necessary height they were taken off by laborers, and carried to the spot where the materials were to be used; when empty they were hung upon the descending side of the chain and lowered to be again filled.

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